

STATUS REPORT #5

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Grant #NsG 148-61 (Suppl. #1)

TITLE: PERIPHERAL MECHANISMS OF HUMAN TEMPERATURE SENSITIVITY

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04

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PC #1

- Objective 1. To obtain information on the variables, e.g., age, sex, time of day, etc., which affect the temperature threshold of skin when adapted to temperatures between 27 and 42° C.
- Objective 2. To provide concurrent measures of changes in the cutaneous vascular activity and the cool threshold as a function of the temperature to which the skin is adapted.
- Objective 3. To investigate the temporal and spatial characteristics of summation of temperature stimuli to produce a threshold response in man.
- Objective 4. To investigate the temporal course of adaptation to thermal stimuli.

STATUS.

Objective 1.

A. Age. As indicated in Status Reports #3 and #4, cool threshold measurements, as a function of the temperature to which the skin is adapted, have been completed on two males and two females, age 21-26, and on one male and one female, age 73-75. Additional subjects for the older group have been tried; however, we are having difficulty obtaining subjects in this age group who are not also on some variety of vasodilator or constrictor medication. Efforts will continue in this direction, however.

B. Sex. No additional work on this topic has been accomplished since the period of Status Report #3.

C. Menstrual Cycle. As indicated in Status Report #3, the preliminary findings have been confirmed that there is a large decrease in the cool threshold when the skin is adapted to temperatures above 35° C. during the period from ovulation to the onset of menses, as compared with measurements obtained during the period from menses to ovulation. During the period of this report, we have successfully manipulated the menstrual cycle by the use of progesterone and progesterone plus estrogen. Oral contraceptives usually consist of heavy doses of progesterone or progesterone in combination with a small amount of estrogen. By prescribing these oral contraceptives on the fifth day of the cycle, we have demonstrated quite clearly that the cool threshold changes as it normally changes on approximately day 14. There is a clear link between the change in threshold with a change in the hormone balance of the female. In addition, we have successfully demonstrated on two of our subjects that accompanying this change in threshold, are changes in the size of the volume pulse as measured by photoelectric plethysmography. During the postovulatory period when the

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cool threshold is small (subject more sensitive to cool stimuli) there is a relatively greater degree of vasodilation at all skin temperatures than during the preovulatory period when the cool threshold is normally quite large.

D. Time of Day. As indicated in Status Report #3, time of day at which cool threshold measurements are made markedly influence the cool threshold. Additional measurements have been made since the period of the last report, which indicate that the cool threshold is correlated with body core temperature, the correlation being significant at the .025 level of probability.

Objective 2.

As stated in Status Report #4, the effect of adrenalin iontophoresis upon both the warm and cool threshold do indeed affect the size of both the warm and the cool threshold. Further data have been collected on this point which indicates that both the warm and cool thresholds increased. The results lend themselves to an interpretation that constricting smooth muscle does indeed directly affect the thermal threshold. Experiments are now under way using other drugs, e.g., nicotinic acid derivatives and nitrates as vasodilators, and ergotamine derivatives as vasoconstrictors.

Objective 3.

A. Spatial summation of warm stimuli to produce a threshold response in man.

Equations fitted to the curves of areal summation on the forehead, forearm and back show that the equation for the curves have the general form of $\log I + K \log A = \text{a constant}$, where I is intensity, A is area, and K is a constant. It is interesting to note that similarity between the form of this equation for areal summation and the Weber-Fechner equation describing changes in the sensation as a function of increased intensity of stimulation.

B. Summation of multiple warm stimuli.

Apparatus has been built and is in the process of being calibrated which will allow timed presentations of two radiant stimuli to different portions of the body. Measurements will commence in May.

C. Critical flicker fusion measurements of the warm threshold.

The nature of the curves for area versus intensity of stimulation to produce a threshold sensation seems to indicate that there is a change in the system which occurs when areas of greater than 4 sq. cm. are exposed to radiant energy. It has been suggested elsewhere that perhaps

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4 sq. cm. represents the size of the peripheral unit responsible for heat sensitivity. In order to investigate this, other methods of measuring heat sensitivity are to be employed. The chief method under investigation here will be the critical fusion frequency for radiant stimuli of various intensities covering the same area and for various areas using the same intensity. We anticipate that should 4 sq. cm. area be a significant point, these kinds of measurements will show similar results and provide further support for the suggestion.

Objective 4.

Modifications to the present apparatus are currently under way in order to accomplish the suggestions made in Status Report #4, concerning ways in which the limits of the temperature to which the skin can be adapted may be investigated. In addition, a third method has been devised which holds even more promise than the one suggested in Status Report #4. This method is a variation of method of average error employed so successfully to plot the course of the dark adaptation curve in vision. The same techniques will be employed to plot the adaptation curve to both increasing and decreasing temperature. The subject will be given a key which, moved in one direction, will cause the temperature of the stimulator to rise, but when moved in the other direction, will cause it to fall. Starting from a fixed skin temperature, e.g., 32°, the subject will be instructed to keep the stimulator just noticeably warm or noticeably cool, depending upon the procedure of the particular session. It is anticipated that the subject will have to increase or decrease the temperature of the stimulator quite markedly at first, but as the limits of thermal adaptation are approached, the curve will become asymptotic. We intend to run this experiment during the final period of support of this grant and data should be completed by the time the final status report is filed.

Articles published during the period of this report

Kenshalo, D. R. Improved method for the psychophysical study of the temperature sense. Rev. Sci. Inst., 1963, 34, 883-886.

Kenshalo, D. R., & Nafe, J. P. The cutaneous vascular system as a model temperature receptor. Perceptual & motor Skills, 1963, 17, 257-258.

Reprints of these two articles have been sent to the National Aeronautics and Space Administration.